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THE
Journal of the Society of Arts,
AND OF
THE INSTITUTIONS IN UNION.

110TH SESSION.] FRIDAY, APRIL 15, 1864. [No. 595. VOL. XII.

Announcements by the Council.

ORDINARY MEETINGS.

Wednesday Evenings, at 8 o'clock.

APRIL 20—"On the Patent Laws." By THOMAS WEBSTER, Esq., F.R.S.

CANTOR LECTURES.

The next lecture on "Chemistry applied to the Arts" will be delivered by Dr. F. CRACE CALVERT, F.R.S., F.C.S., corresponding member of the Royal Academy of Turin, of the Société Industrielle de Mulhouse, of the Société Imperiale de Pharmacie de Paris, &c., on Thursday evening, at 8 o'clock, as follows:—

APRIL 21.—LECTURE IV.—ANIMAL FATTY MATTERS, the various processes for liberating them from the tissues in which they are contained. Their composition and conversion into soap. Composite candles. The refining of lard. *Cod-liver*, *sperm*, and other oils. *Spermaceti* and *wax.*

APRIL 28.—LECTURE V.—FLESH, its chief constituents, boiling, roasting, and preservation. *Animal black*, its manufacture and applications. The employment of animal refuse in the manufacture of *prussiate of potash. Prussian blue.* Manufacture of artificial animal manures.

MAY 5.—LECTURE VI.—ANIMAL LIQUIDS.—*Bile*, its purification and detergent properties. *Blood*. its application in the refining of sugar and the manufacture of albumen. *Albumen*, its use in calico printing and photography. *Urine*, its uses. *Milk*, its composition properties, falsification, and preservation. A few words on putrefaction.

The Lady-day subscriptions are now due, and should be forwarded by cheque or post-office order, made payable to the Financial Officer, Samuel Thomas Davenport. All cheques and post-office orders should be crossed through Messrs. Coutts and Co.

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 13th, 1864; Dr. Edward Smith, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Farries, R. Spearman E., 13, George-street, Mansion-house, E.C., and 40, Basinghall-street, E.C.
Mostyn, Charles, 8, Cornwall-villas, Westbourne-park, W.
Yeats, Anthony George, Collinson-house, Effra-road, Brixton, S.

AND AS HONORARY CORRESPONDING MEMBER.

Menn, Charles, Secretary of the Institute of Science, Geneva.

The following candidates were balloted for and duly elected members of the Society:—

Dircks, Henry, 16, Bucklersbury, E.C.
Gladstone, Thomas Murray, Lloyd's Proving House, West India Docks, E.
Hodson, Francis, 6, Furnival's-inn, Holborn, E.C.
Keeling, E. Bassett, 4, Verulam-buildings, W.C.
Peterson, Charles, Newport, Isle of Wight.
Slade, Jeremiah, 102 and 103, St. John-street-road, E.C.
Turner, George, Northfleet, Kent.

AND AS HONORARY CORRESPONDING MEMBER.

Fowler, John Townshend, Madras.

The Paper read was—

ON A NEW PROCESS OF PRESERVING MEAT

BY JOHN MORGAN, ESQ., F.R.C.S.I., PROFESSOR OF PRACTICAL AND DESCRIPTIVE ANATOMY IN THE ROYAL COLLEGE OF SURGEONS, IRELAND.

Before entering on the subject of my improved method of preserving meat for navy, marine, and other purposes, it may be desirable to allude to some of the processes at present in use, which can be put under the head of—

1st. Enclosing in canisters, so as to exclude air.
2nd. Encrusting with varnish of different kinds.
3rd. Salting, whether in tanks of brine or dry salting.

As to the first, the practical result is, in a great degree, that salted provisions are preferred by the seamen, as remarked by one of the oldest and most accurate observers, Sir G. Blane,[*] who says "That men are very apt to tire of a long continuance of fresh provisions, but never of what is salt." The meats preserved in tins are mawkish, and taste of the metal, besides that they are costly in preparation and carriage, and not applicable for victualling on a large scale, are not capable of extempore preparation, and require expensive apparatus. If the meat be previously parboiled or soaked in water, the fluids are extracted, some of the most important nutritive elements being thus lost.

2nd. As to encrusting with varnishes—This method is imperfect, from the difficulty of thoroughly coating over the chinks and inequalities of the flesh; the risk of taint, when subjected to damp, or when any spot is exposed, are great objections, as well as the expense and labour of covering each piece, though where this is not any great object, and the materials to be preserved small in bulk, the plan might be found applicable in a financial point of view.

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[*] "Diseases of Seamen," page 296.

3rd. As to salting. The method usually practised at all curing establishments is as follows:—After killing the animal in the usual way, it is cut up in twenty-four hours (in 8 lb. pieces if beef, in 4 lb. pieces if pork) for navy stores, rubbed with salt, and then placed in tanks of dry salt for a certain number of days—eight to twenty-one, or even more, according to judgment. A brine is formed, containing, as Liebig* expresses it, "the soup or a concentrated infusion of meat." "Also," he adds, "in salting, the albumen is separated from the flesh, as well as the phosphoric and lactic acids, potash, and kreatin, &c. It is easy now to understand that in the salting of meat, when pushed so far as to obtain the brine just mentioned, a number of substances are withdrawn from the flesh which are essential to its constitution, and that it therefore loses in nutritive quality in proportion to this abstraction. If these substances be not supplied from other quarters it is obvious that a part of the flesh is converted into an element of respiration, certainly not conducive to good health.

"It is certain, moreover, that the health of a man cannot be permanently supported by means of salted meat if the quantity be not greatly increased, inasmuch as it cannot perfectly replace, by the substances it contains, those parts of the body which have been expelled in consequence of change of matter, nor can it preserve in its normal state the fluid distributed in every part of the body, namely, the juices of the flesh. A change in the quality of the gastric juice, and consequently in the products of the digestive process, must be regarded as an inevitable result of the long-continued use of salt meat."

The meat, now deprived of its albumen in a great degree, of its phosphoric and lactic acid supply, of its potash, salts, &c., is for navy purposes or for casked provisions, packed in barrels of large crystallised salt (St. Ubes) and pickle—a head or overplus of the salt being placed at each end. The result is, that in process of time, a still further abstraction of the nutritive material takes place; the large crystallised salt, being purer, effects this more perfectly, so that in some months the remark of Sir G. Blane and others is not, perhaps, exaggerated, "that the meat has no more nutrition than saw-dust or the bark of a tree†." "Ornaments may be cut out of the meat, resisting the knife like wood."‡

Dr. Hammond, Surgeon-General to the United States' Army, 1863, in his treatise on Hygiene, page 491, remarks, "Individuals therefore subjected to a diet consisting mainly of salted meat are not properly nourished, and hence the constitutional disturbance (which, under such circumstances, is always manifested) is due not to the direct action of the salt, but to the absence from the food of matters which are essential to the well being of the organism. It is sufficient in this place to state, that scurvy and other forms of cachexia which follow the prolonged use of salt meat, are not the direct consequences of the large quantity of salt ingested."

It is evident that by the usual process the meat is deteriorated to a very great extent, more so perhaps than is generally supposed, and that the evils attributed to the taking in of salt are not due to its action—but to the removal from the system of the constituents natural to muscle juice. It will be interesting to inquire how far this deprivation injures the meat. As remarked by Liebig ("Letters on Chemistry," page 446), "flesh by salting loses in point of nutritive value, in consequence of the removal, soluble and insoluble, of the salts indispensable to sanguification, in the same way, if not in the same degree, as that which is well boiled; of three cwt of meat, by the full action of salt, one cwt. may be rendered useless for the vital process"; that this is the case the following analysis will prove:—

Of Salts.	Grains.
10 lbs. of fresh meat give 2½ oz. or.........	662·8
10 lbs. " " exhausted by lixivation and boiling, give to the soup	544·7
Remain in the flesh only	118·1

	When boiled there enter Soup.		Remain in meat.
Phosphoric acid.........	26·24	....	10·36
Potash	35·42	....	4·78
Earths and iron.........	3·15	....	2·54
Sulphuric acid	2·95	....	
Chloride of Potassium	14·11	....	
	81·87		17·6

The following celebrated experiments of the French academicians amply prove that meat deprived of its soluble matters cannot efficiently support life. A dog, weighing 12lb. 6oz., was fed daily with ½lb. of boiled flesh, softened in water, thoroughly expressed and freed from fat as much as possible; he lost in the course of 43 days one-fourth of his weight; after 55 days his emaciation was extreme; he could hardly eat the fourth of his ration, and his utter exhaustion was evident to the eye; the animal continued lively, his hair was shining, and he showed in no respect the symptoms of consumption from disease, but rather looked like an animal which had good food, but in quantity far inferior to his wants. On the other hand, dogs fed daily with the same weight of raw flesh, which contained more water and less solid matter than the boiled, and of the poorest quality (sheep's heads), exhibited, after 120 days, no signs of disturbance of health, and sustained their full weight. The loss of nutritive power in the flesh was obviously caused by the removal of the ingredients of the soup—what perhaps occurs even in a greater degree in ordinary curing.

I would here subjoin, and request attention to the composition of flesh, according to Liebig:—

Reaction acid.	Water, 76 to 79 per cent. Albumen, 2 to 14 " Phosphoric acid. Lactic acid. Phosphate of potash. Chloride of potassium. Kreatin and kreatinine—found in all higher animals. Inosinic acid. Fibrine, 70 per cent. of dried flesh.

Having thus shown that the deterioration of the meat is caused not by the presence of salt, which we all know is instinctively sought after, but by the taking away of the several ingredients alluded to, I propose explaining the means, mechanical and scientific, I adopt for the retention or addition of these substances, and offer for inspection and tasting by the members present the several specimens on the table, kindly allowed me by the Comptroller, cured for navy stores at the Royal Victoria Victualling Yard, Deptford, in presence of the comptroller and officers of the yard. These operations were necessarily carried on with extemporised arrangements; nevertheless, as can be testified by your secretary, amongst others, in six minutes or less the entire animal was "cured" and ready for casking, no materials being abstracted from the flesh.

In the method which I desire to bring before you preservative fluids are injected into the tissues of the meat by means of the circulation, so that every particle of the flesh is reached; these means, being already formed and used by nature, are of necessity complete and perfect, if properly taken advantage of, but this has hitherto not been done.

I shall first detail the *modus operandi* of my process. The animal is killed in the usual manner by a blow on the head, causing instantaneous death. It is then turned on the back, the chest opened, the bag or pericardium, containing the heart, opened. The right side of the heart, into which all the venous or returning blood enters, is seen distended; the ear or right auricular tip, as most convenient, is opened, or its tip cut off, or an incision made into the right ventricle, another also directly into the left. The animal is turned on the side to let the blood run out. A pipe, furnished with a stop-cock and coupling at the outer end, is now introduced into the incision made in the left ventricle, and makes its way at once into the aorta. The fingers, holding a piece of stout cord, are now passed round the aorta, close to the heart (including at the same time the pulmonary artery), and the cord is tied strongly over both, so that the pipe is fixed in the aorta firmly. To the outer end a coupling, connected with an india rubber or other tube, three-fourths of an inch in diameter, 18 to 20 feet long, joins this to a vessel or tank elevated to the height of the length of the tube; brine of ordinary strength, with a little saltpetre dissolved in it, is let on; it directly (under fifteen seconds in most cases) rushes out at the incision made either in the right auricle or ventricle, before mentioned. About five gallons will suffice. This clears the smaller vessels for the next stage, which is the essential one. The brine so used can be recovered if desired by adding a little old brine and heating. The materials to be ultimately used are now put into the tank, taking care that they are strained, and a stout clip or clamp is put on the incision in the right side of the heart. The fluid is then turned on and directly makes its way to the right side, as before, but its exit being now prevented, and its admission into the smaller vessels being secured by the first process of clearing these vessels, as mentioned, the fluid, by the pressure and the capillary attraction of minute vessels and muscular fibre, precolates through every particle of the animal, and can be seen at the moment diffusing itself in any part, by making incisions in the hide, horn, bone, and flesh, or any other parts. The quantity I use is about one gallon of brine to the cwt., a quarter to half a pound of nitre, two pounds of sugar, a little spice, sauce, &c., to taste; also ½oz. of the mono-phosphoric acid, which, having the power of coagulating albumen and forming a compound with it, retains this very desirable element in the flesh, and gives an extra supply of phosphoric acid, which is of course at present denied the sailor, as above stated. The use of boiling brine in the second stage I also advocate, as it coagulates the albumen or gives a set (as it is called by cooks) to the meat. It is needless to remark that the entire animal is cured almost instantaneously.

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* "Chemistry of Food," page 135, Liebig.

† Diseases of Seamen, p. 442.

‡ Armstrong, Naval Hygiene, p. 30, 1858.

I would now draw attention to the further treatment of the flesh, referring to

1st. The method scientifically used;
2nd. The advantages attained ;
3rd. The mechanical advantages ;

if we now consider the first part of the process complete.

The animal is in a few hours cut up into the 8lb. pieces required by the navy, and is ready for casking in the usual way, or in dry salt (all expense of preparing being done away,) or for drying by being transferred to a drying-house (as in the specimens for inspection). It is obvious that it loses none of those materials abstracted by the present method of salting, so that the meat is absolutely perfect, as in fresh meat without water, having, as I hold, the additional advantages of salt[*] which the weight of authority is in favour of rather than against, and of sugar, now issued to the navy, along with the lemon juice; the use of sugar Liebig shows plainly is for the formation of lactic acid, (which, as mentioned before, he has found abstracted by the brine), and a most essential compound not only of muscle juice, but of gastric juice, as well as an important respiratory food. I would suggest the use of "sauer kraut," or some other vegetable product containing lactic acid, or lactic acid itself. Sugar is, in an economic point of view, specially advantageous, as it is about two-thirds the price of meat, or less, while it improves the flavour and keeps soft the flesh, aiding also in the preservation.

Phosphoric acid, abstracted by the same plan, I propose to add to the meat used for the navy, to make up for the deficient vegetable supply, a material eminently useful, especially in its monobasic form, as recommended by Prof. Galloway from its various qualities of coagulating albumen and retaining it in the flesh, from its known utility in the system, as an essential in muscle juice, also for the formation of phosphate of soda in the blood, this salt performing an office essential to life, in holding carbonic acid in solution and carrying it to the lungs.[*] Gastric juice also contains this acid in health; it has no means of getting it from the flesh prepared in the ordinary way, but it must be supplied by vegetable substances, as by lemon juice. An analysis was recently made by Professor Galloway of two specimens of lemon juice, one bought at a druggist's, and the other supplied by the Admiralty; they were found to contain a very considerable quantity of phosphoric acid, the sample from the Admiralty giving the following results:—In one gallon of lemon juice, phosphoric acid equal to 91 grains of anhydrous phosphoric acid, and this equals 458·5 grains of ordinary phosphate of soda (2 NA O, HO PO_5 24 HO). This acid is not given in the usual tables of the components of lemon juice, nor has it, I believe, been before looked for, as the other acids contained are citric and malic in small quantity, and as these have been given medicinally with but little benefit for scurvy, it is sufficient proof that as the seaman is deprived of this important element of the body in his meat, he derives benefit from its being added artificially in lemon juice. I am here again desirous of quoting the words of Liebig with regard to this component, bearing in mind that it is found in some form

In blood
In muscle juice
In gastric juice
In bones
In nervous matter
In viscera, as liver, kidney, lungs.

He remarks ("Letters on Chemistry," page 409), "In the present state of science it is not possible to express a decided opinion as to the mode of action of the phosphoric acid in the organic process, and we must for the present be satisfied with deducing from its constant presence in all the juices and organized tissues of the body the conclusion that it is indispensable to the vital process." Muscle juice is also found to contain this acid largely, and as Liebig supposes, probably by the acidity of muscle juice and the alkalinity of blood, a modified galvanic action is kept up, preventing in health the filtration of one fluid into the other.

The potash salts found in flesh juice, and abstracted by the brine, can be added as found desirable. I have used the nitrate, but the phosphate or other forms are equally manageable.

I may be allowed here to suggest the probability of the cause of scurvy being chiefly the want of supply of the lactic and phosphoric acids as well as of the potash salts; hence the early symptoms of dusky hue of skin, breathlessness, palpitation, and symptoms of imperfect respiratory process from want of the necessary salt, phosphate of soda, in the blood, and the more early appearance of scurvy in cold latitudes, where the respiratory process should be more energetic; the deficiency of lactic acid and other elements is shown by the early muscular debility, and the endosmose and exosmose of the blood and muscle juice. All authorities agree in the altered condition of the blood, which I believe depends on the want of phosphatic supply, the action between blood and muscle juice (as alluded to above by Liebig) being abnormal, the extravasations take place from altered specific gravity and reaction, hence the solutions of bone and separation of the epiphyses in extreme cases from the avidity in the system for phosphatic supply.

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[*] See article Scurvy, "Library of Medicine," vol. 5, page 32, by Dr. Budd.

[*] "Liebig's Chemistry of Food."

That the want of acidity of the muscle juice and altered conditions of the blood are the causes of scurvy, is also supported by the fact that "sauer kraut," molasses, wines, &c., are antiscorbutics.

The nervous depression may also be explained by the want of phosphatic supply to the nervous centres.

The retention of the albumen I attain apart from the addition in some cases of the mono-phosphoric acid, by the use of boiling brine; as its temperature is higher than that required to coagulate albumen, I diffuse it by my process, through every part of the flesh, where this material can be seen around the muscular fibres like milk. As flesh contains about one ounce of albumen in every three pounds weight, and this weight is made of 72 per cent. or more water, the advantage of retaining the albumen can be easily seen. By the retention of the albumen the meat is also kept more tender and "short," and is consequently more easy of digestion.

Its importance as an element of food cannot be overrated when we reflect on the composition of the egg, and observe that everywhere throughout organised nature where animal life is developed, we find the phenomena of life depending on its presence.

How far I have succeeded, the analyses I now give will explain: these have been made by R. Galloway, F.R.S., Professor of Practical Chemistry, Museum of Irish Industry, the meats, except the first part, being supplied by the Admiralty for analysis—though the complete investigation of them has not been concluded.

Fresh beef, about 4 years old, killed 23 hours, gave—

1. Water	73·18
Solid matter	26·82
	100·00

Beef cured by my method, February 2, 1864, and casked as usual—

2. Water	56·61
Solid matter	43·39
	100·00

Beef cured at Deptford by the usual method, February 2, 1864—

3. Water	51·75
Solid matter	48·25
	100·00

Per centage of albumen of meat dried at 212°—

	Per cent.		Per cent.		Per cent.
No. 1.	8·16	No. 2.	9·24	No. 3.	5·49

Shewing, that in the meat prepared by my process, the quantity of albumen rather exceeded that in No. 1. (probably from the feeding and age), and that the ordinary process lost albumen largely.

The operation, though scientific, and based on anatomical principles, is simple, and practical in the extreme; it can be learned and practised by any ordinary hand after one or two operations. No machinery is necessary beyond the pipe and stop-cock, coupling and clamp, in all costing about 12s., some tubing, and a barrel or tank. No rubbing or further manipulation is required, this being in itself a vast saving of labour and time; as, in my opinion, the sooner the flesh is put to dry, the better, and if to be casked it may be packed directly; the albumen being coagulated, and sugar being already added, (phosphoric acid if desired, but for the navy recommended) and nitre. I prefer the meat being put in dry salt, to the ordinary method, but this is nearly immaterial.

The process occupies three minutes for the first stage, and a little less for the second; the entire period from killing the animal till hanging it up flayed and disembowelled, being twenty minutes, and this by men unaccustomed to the work. The danger of taint is obviated, because the cure takes place from within out, and not as in ordinary cases the reverse.

It is allowed (I believe and am so informed) that when the meat, salted by the ordinary means, is weighed for messes, it is found to have lost in weight. By my method there is no loss, save water in the case of dried meat, and if the meat be casked, the sugar being added, the material is kept soft, and does not lose nutrition. Spices, flavorings, antiscorbutic remedies, if desired, can, with ease, be added and proportioned; the spices would, in a great measure, supply the place of salt.

A most important element in my method also is its simplicity, so that in case a ship touched at land where animals were abundant and cheap, a stock could be extemporaneously prepared of dried or casked meat. I would propose that an officer be specially instructed in the application; and weather or climate would be comparatively no difficulty—sheep, swine, and all mammalia being suitable.

I further draw attention to a fluid for preservative purposes, made of a solution of mono-phosphoric acid. The meat should be soaked some time and washed before boiling; of course it must retain all the elements natural to it.

Having thus put before you the chief features of my invention, I shall be happy to give any further information. I believe improvement is required in the meat of the sailor and soldier, as too easily proved in the late war, and specially for that much-neglected and ill-used section of society—the merchant marine, some portion of it at least. I have, I trust, succeeded in at last accomplishing a simple, efficient, economical, rapid, and scientific method of preserving meat for such purposes as are required.

The victualling department of the navy have had a number of bullocks prepared by this method, and have shipped them to various climates to test the efficacy of the process.

I subjoin a rough list of the improvements to be attained by this process:—

1. No rubbing with salt.
2. No putting in tanks of salt, or labour.
3. The operation requires for a bullock only an extra time of five minutes or thereabouts.
4. No machinery required.
5. No loss of weight.
6. Diminution of taint.
7. Cure possible in other than the winter months, when meat is cheaper.
8. Not increasing the market price by purchasing so many animals together.
9. Making dried meat containing all the nutriment without extra expense.
10. This dried meat will make soup, and
11. It can be carried conveniently.
12. Two or three days' supply would be portable (if dried) by each man without difficulty.
13. Being parboiled, or "set," it can, when dried, be eaten without cooking if need be.
14. Spices and flavours can be added economically.
15. Anti-scorbutic remedies or vegetable products likewise.
16. Applicable to extemporaneous use.
17. The hide and every part of the animal is cured at once.
18. Every part of the animal is cured so that the shins head, &c., can be used.

DISCUSSION.

Admiral Sir **Edward Belcher** considered this process a very valuable one, as dispensing with the severe manual labour of salting provisions by the ordinary means. As much as 70 years ago, however, meat was cured with sugar, though a different process was adopted to that described this evening. Meat had been sent from Nova Scotia to Jamaica in treacle, or cured with sugar, and it remained perfectly good. He considered Sir Gilbert Blane's idea with regard to scurvy quite erroneous. Very few persons had investigated the question of scurvy amongst seamen more carefully than he (Sir E. Belcher) had done. For 25 years he took care of his own ship's company without the assistance of a medical man, and during that period he directed his attention to securing for his seamen everything which was supposed to tend to the prevention of this disease. As far as lime-juice was concerned, he discarded it altogether from his regimen. During one of his Arctic voyages he gave this to the men, because they were not allowed to drink the ice-water, but he believed the anti-scorbutic properties were in the sugar mixed with the lime juice, rather than in the juice itself. It was quite true, as stated by Mr. Morgan, that seamen preferred salt provisions, and that the dislike to turtle was general amongst them. An Englishman, attempting to eat turtle by itself, would be disgusted with it, however much it might be prized in this country, where it was a mere vehicle for other condiments that were added to it. With regard to Sir Gilbert Blane's idea as to drinking sea-water, if he had studied the effects of sea-water upon the human frame, he would have understood that he might have given his men as much salted provisions as he pleased, without producing disease; but if only a very small quantity of sea-water got into a tank of the fresh water used for drinking, many varieties of diseases would be produced. From experience he had had with ships' companies on the coast of Africa he found that fresh provisions with fruit added did not prevent scurvy, which prevailed to such an extent that he had to come to England for a fresh crew. That disease, in the case he referred to, he believed to have been occasioned by the men wearing damp clothing, but as soon as he discovered what he believed to be the cause, he insisted that they should be examined every night to see whether they had dry flannels on them. Scurvy, moreover, was known in England quite apart from salt provisions, particularly in gaols. When the expedition under his (Sir E. Belcher's) command was about to proceed to the North he obtained permission from the Admiralty to have a considerable portion of the provisions cured in his own way, viz., with sugar. The meat was rubbed with sugar till it absorbed it to a great extent, and a coating like varnish was formed on the surface. It was also rubbed with salt, and packed dry. He had eight casks prepared in this way in February, 1852, and in July of the same year, he gave his officers good beef-steaks from that meat. On the two following Christmas days, they had roast beef from it; and after five years and eight months, he sent a round of beef to the Admiralty, which was in good fresh condition, with good fat on it. He therefore advised Mr. Morgan to add a little more sugar to his mixture. With respect to dried meats, he would mention that about the year 1820, a method of preserving meat with pyroligneous acid was adopted. Admiral Sir Thomas Cochrane sent out a quantity of provisions so prepared to Barbadoes: and two years after he (Sir C. Belcher) ate some of that meat at the admiral's table at Bermuda. He, however, strongly approved of the sugar curing, because it preserved the juices of the meat better than any thing else. With regard to the necessity of meat as a food in hot climates, he would remark that in the islands of the Pacific the natives did not eat meat at all, and if they did so they were visited with violent cutaneous eruptions. The Admiralty were so satisfied with the superiority of the sugar process that on his (Sir E. Belcher's) return in 1854, they applied to him for his recipe, but he was not aware that it had ever been used in preparing the navy provisions since that time. With respect to the remarks as to the inferior victualling of the merchant marine he could not agree with Mr. Morgan, his (Sir E. Belcher's) opinion being that the meat supplied to the merchant seamen was superior to that which they got in the royal navy. In conclusion he would say he fully appreciated the value of this process, but he strongly advised Mr. Morgan to store the meat in dry salt instead of wet pickle.

Sir Joseph Paxton, M.P., was quite sure the meeting must have been exceedingly gratified at the very able manner in which this subject had been treated by Professor Morgan. He (Sir J. Paxton) had not looked at it quite in the same point of view as the gallant gentleman who had just addressed them, but he had regarded it more in a commercial and sanitary light. This was a subject of much interest, and there was a bill now before Parliament with respect to the examination of meat unfit for human food, but the question was so difficult to deal with that he believed Parliament would be able to do little in the matter till they were better informed on the subject. It struck him that this ingenious process would enable persons in distant parts of the world to send meat to this country, in very large quantities, in a better state than hitherto we had been accustomed to receive it in London from the more distant parts of England, and probably it would be found better for us to import meat from different parts of the continent cured in this manner, than for the cattle to be sent alive, causing in many instances a great amount of suffering to the animals in the passage, as well as injuring the quality of the meat. Regarding the present very high price of meat in this country, he looked to a more extended field for the supply of that article, and it appeared to him that it was only by the application of the increased chemical knowledge of the present day that we could hope for an adequate supply of meat to be brought to this large consuming market. In some parts of South America cattle were slaughtered to a large extent merely for the sake of their hides, while the disposition of the rest of the carcase was a matter of serious difficulty. Seeing, therefore, that the length of passage by steamer would not be more than about a month, a process by which not only the hides but the meat could be made available for our market would be most valuable in every point of view. Although this process might not be new as regarded the materials employed, yet the mode of their employment was so, and the effect appeared to be remarkably satisfactory. He had no doubt a little more sugar would do no harm, and there was no difficulty in adding that if it was found to be wanting. He could not but tender to Professor Morgan his cordial thanks for the admirable way in which he had introduced and illustrated his subject.

Mr. Winkworth said that he did not rise to enter into the discussion, but to ask a question of Professor Morgan, which was suggested to him by something which had fallen from Sir Joseph Paxton. He wished to inquire whether the process had been tested in tropical climates. He asked this because it was known that in some parts of South America, and elsewhere, cattle were bred solely for the purpose of curing and transmitting the skins to Europe, as a valuable article of commerce, while the denuded carcasses were left to birds and beasts of prey, or otherwise disposed of, but not always in time to prevent that offensive decomposition which must immediately ensue in such hot countries. Even in other remote spots, such as the Falkland Islands, which enjoyed a temperature similar to our own, the sparseness of the population, and the impossibility therefore of disposing of the meat, rendered the application of a process of preservation like that which Mr. Morgan had brought so graphically before the meeting, most important.

Dr. Bachhoffner said, although the process could not be regarded as a new discovery, he believed it would be most valuable. Some years ago Mons. Gannal, of Paris, introduced a process of embalming effected in a somewhat similar manner to that described by Mr. Morgan. It was true that the one was for the preservation of a dead body—the other, the rendering of a carcase palatable. The materials used by M. Gannal were poisonous, but they rendered the body incorruptible. In the process exhibited to-night, he thought there were certain points which required a little more explanation. In the first place, with regard to the "washing out," it was a question whether they were not taking away valuable substances which nature had supplied. This "washing-out" was very much like bleeding an animal to death, by which they lost much of that nutritious matter which otherwise would remain in the carcase. Then, again, there were introduced certain saline matters, not so much for the sake of preservation as to add that of which it was alleged Nature gave an insufficient supply, such as phosphoric acid, &c. As regarded the sugar which was to furnish the lactic acid he could not conceive that by introducing sugar into a dead carcase it could be converted into lactic acid. That was a result produced only in a living body. It would answer as well to eat the sugar apart from the meat. He remembered a few years ago a patent was taken out for the preservation of meat at Barbadoes, where it was required to be eaten very soon after it was slaughtered. That process consisted in forcing brine into the meat, after it was cut up, by hydraulic or pneumatic pressure, but it failed. By Mr. Morgan's process, however, the brine was introduced into every part of the flesh in the most perfect manner, but with respect to a portion of the ingredients injected, some people might prefer to have the meat in a state more allied to its natural condition. He believed this process to be a most valuable one, and he hoped it would relieve seamen from the necessity of eating such strongly salted provisions as they were now often compelled to consume. He had seen "salt junk" so hard that when it was polished it looked almost like mahogany. With regard to preservation in tins, he had tasted meat that had been preserved for twenty years, but he did not consider it palatable.

Mr. **John Bethell** said that about twenty-two years ago a patent was taken out in which a process was described which appeared to be very similar to that which had been just brought before them. He knew himself that sheep had been thus prepared in Smithfield, and a great deal of trouble was taken by persons interested to introduce the process commercially, but it failed—for what reason he did not know. He agreed with those who had preceded him that this process was most useful, and he should be sorry to say one word derogatory to it. He agreed with the last speaker on the subject of the "washing out." He imagined the intention was to wash the remaining blood out of the veins, which was similar to bleeding to the last drop. He believed it was considered that that injured the nutritious qualities of the meat very much, and he should not have thought there was any necessity for it. He thought the vessels might be impregnated with the saline matters or sugar in solution without getting rid of the blood. Some years ago it was advanced that the meat would be better if the animal were killed without bleeding; death by suffocation—by puncturing the chest and pumping in air so as to compress the lungs—was recommended. He thought it would be a great benefit to sailors if this system were introduced. He was perfectly aware of the difficulty there was in getting the Admiralty to move in matters of this kind, having himself, during the Crimean war, introduced a process of preserving meat in small pieces, dried at a temperature below that at which the albumen was coagulated, and when soaked for a time in cold water the original properties of the flesh were restored. Some of the meat so prepared was sent out to Africa, but it was said the sailors did not like it, and the process was not continued.

The **Chairman** said the meeting could not fail to have been interested and much instructed by Mr. Morgan's admirable paper and the discussion upon it. Some present might not be aware that the Society had offered a large prize for the best method of preserving meat, &c., and the communications sent in on that subject remained to be referred to a committee to decide upon, and the Society did not commit itself the merits of any process—the process now before them—or any other. It was necessary that they should keep the practical part of the paper separate from the speculative. He thought it was the former that this Society had more particularly to deal with. The theories advanced by Mr. Morgan as to the causes and prevention of scurvy might be correct or not, but the discussion of them would hardly be desirable on this occasion, as they did not affect the merits of the process. A question had been raised as to what they should introduce into the flesh as the curative material. He had no doubt sugar was a good preservative, and it was commonly used for the best hams and bacon. He thought that with regard to the effects of the ordinary salting process, Mr. Morgan was borne out by scientific facts. If meat were salted in the ordinary way there was no question that a large portion of the fluids was extracted, while salting from the inside, as practised by Mr. Morgan, preserved most of the nutritious juices of the meat, although when cut up into joints a certain portion of those juices would no doubt exude. With reference to the phosphates he considered they were important, as they were found in nearly every description of food, and to persons in a position to obtain a sufficient quantity of mixed foods the natural supply of phosphates would be sufficient, but the cases now in question implied circumstances in which a mixed diet could not be obtained. Then it became a question whether a small artificial admixture of phosphates was not an advantage. He was struck with the importance of this process in connection with the importation of foreign meats into this country. No less than 2,000,000 of cattle were said to be slaughtered annually in South America, for the sake of their hides and hoofs alone. He was not certain whether even the fat was made use of. Therefore, in a commercial point of view, this process promised well. Meat was greatly wanted in this country at a less price than it could now be obtained. The great question was what would be the future of this process. He apprehended as yet sufficient time had not elapsed to test it thoroughly, and they had to find out by experience whether it was as efficient in preservative power as the system at present in use. With reference to the bleeding he confessed, consulting his personal feelings in the matter, he approved of the Jewish mode of slaughtering, by cutting the throat and bleeding, and no better meat than that killed on the Jewish plan could be obtained. He was quite sure the meeting would authorise him to tender to Mr. Morgan their grateful thanks for his very interesting paper.

Mr. **Morgan**, in replying upon the discussion, said with regard to what had fallen from Sir E. Belcher, he had not brought forward the process of curing with sugar as a new thing. He would prefer a larger quantity of sugar: but even 10 or 12 lbs. of that article as applied by him, was rather an innovation as far as it went. He was quite aware that meat had been preserved for a very long time either in treacle or glycerine, both being materials which excluded the air. With regard to Sir Gilbert Blane, he had referred to him merely as a practical man, and an old authority on the subject of scurvy, which he believed was only another name for a certain degree of starvation. As to the effects of drinking salt water, Sir E. Belcher had correctly described the symptoms of men dying of thirst, which proved that the blood refused to take an amount of saline matter beyond its natural constituents. If a number of glasses of water were taken by a person at short intervals, the kidneys would secrete the water in the proportion in which it was taken, but if salt to even a small per-centage were added, after the second or third glass the stomach revolted at it, and the blood refusing to take it in, the effects mentioned would be apparent. With regard to damp clothing, it was injurious, inasmuch as it interfered with the respiratory powers of the skin, which was, in fact, a great lung. With regard to the question of removing the blood, he confessed he was not an advocate for keeping this in the carcase. The Jews might be regarded as great flesh-eaters, and, consequently, a vigorous and enduring race, and under the Levitical law they were forbidden to eat the blood, and under thier system of slaughtering animals for food great care was taken that all the blood was extracted: therefore, according to the Divine authority of the Levitical law, which at least must be admitted as eminently hygienic, he considered the blood ought not to be retained in the meat, seeing it was inculcated from the time of Noah, to the "necessary things" of the Apostles. Such a practice certainly would not be favoured by butchers themselves, because the blood was a great decomposing agent, and remaining in the vessels would disgust the consumer. They must also recollect that a diseased condition of the blood must first be supposed to exist before its effects were seen in the system, and even the mode of death altered its condition and possibly even composition. On the question of the quantity of blood in an animal, he believed very erroneous notions were entertained. In the sheep which they saw before them they had seen that before a quart of the fluid had been injected by his process, it began to issue freely out of the opposite side of the heart. It had been said that the human body contained about 26 lbs. weight of blood. If that were the fact, a person would hardly be affected with fainting on losing 10 or 12 ozs. of blood; yet such was usually the case. He hoped on every ground that the blood would never be retained in meat used for food. As to the temperature at which the drying process was effected, Mr. Morgan pointed out some specimens which had been dried in the biscuit loft over the bakery at Deptford, at a heat from 104° to 120°. In dividing the carcase for drying, discretion should be used as to the size of the pieces and the temperature; if the pieces were too large or the heat too great, before the water could be given off decomposition would set in. He hoped to see a larger use of dried meats than was now the case, as they presented so many advantages. With regard to the application of this process in very hot climates, he would mention that an agent had been sent out to practice this method of preserving meat in Monte Video, and he hoped soon to see some satisfactory specimens. With reference to the preservative process of M. Gannal, mentioned by Dr. Bachhoffner, it consisted of the injection of poisonous materials, and of chloride of aluminium, by means of a force-pump, through one of the large blood vessels of the neck, which had the effect of slowly mummifying the dead body. Of course, where poisonous solutions could be used, there was no difficulty. In reply to the speaker who suggested that the quality of the meat might be deteriorated by the ingredients used in the curing, he wished it to be understood, that he used those materials which were ordinarily employed in curing meats, and he preferred to use them in a boiling condition, because this caused the albumen to "set" at once, which had the effect of making the meat more tender when eaten, and preserve better. He did not say it was essential to "doctor" the meat, though he believed the addition of a certain small proportion of phosphoric acid was of great importance, for seamen who could not, under ordinary circumstances, be supplied with the requisite amount of that material to be derived from other articles of food. As to the preservation of meat with sugar, if they used sugar alone, the expense would be very great, and Barbadoes would not supply enough for the large scale on which the curing was carried on at Deptford; but he thought there was an advantage in using sugar as an ingredient, to the extent or even more than he suggested. With regard to the objection that his plan was not new, he would say he had paid some attention to the different methods that had been adopted, and amongst others, to that of Mr. Long, to which he believed Mr. Bethell referred. The plan of operation in that case was to fill the vessels with forcing machinery, introduced into the ventricle of the heart of the animal, and this to be held by a man's hand, and that as soon as the fluid flowed back the operation was complete; but he questioned whether any four persons in the room could, with their hands round the ventricle of the sheep before them, hold it so as to inject all the arteries and capillaries in the way he had done this evening. He held it to be a totally different process to his own. There were not two openings made in the heart, or two stages; the theory and principles were not the same. Injection for subjects for dissection had been practised for more than a hundred years, but the process alluded to was merely a bad and unskilful way of doing it.

Mr. Bethell said he referred to the plan of Mr. Perks.

Mr. Morgan believed that to have been Mr. Long's patent. One argument in favour of his (Mr. Morgan's) plan as against that mentioned by the speaker, was, that the latter was admitted by him to be a failure, whereas his was not. He hoped before many months were past they might have meat from South America and at home of good quality and at a cheap rate.

The author illustrated his process by showing its application to a sheep recently slaughtered. A bucket of brine was raised to a height of about twelve feet, and a tube connected with it inserted into the heart of the animal, as explained in the paper. The vessels were thus washed out, and the preservative fluid was then injected, the whole operation occupying but a few minutes. Specimens of meat prepared by this process, that had been kept some months, were on the table, and were tasted by many of the members.

Proceedings of Institutions.

Chatham, Rochester, &c., Mechanics' Institute.—The twenty-seventh annual report states that the receipts from ordinary sources have considerably exceeded the expenditure, and that a very large sum besides has been realised by the reading given by the President, Charles Dickens, Esq., to whom the committee take this opportunity of returning their very sincere and heart-felt thanks. But for the generous aid which has been rendered on former occasions, there is little doubt that the Institution must have been closed long since; his name has given to it a prestige which it could not otherwise have obtained; and the profits derived from his readings have enabled former committees to meet their heavy responsibilities, to add from time to time largely to their library, and in other ways to maintain the efficiency of the Institution. They purpose devoting a sum of about £50 out of the £73 derived from Mr. Dickens' last reading to the purchase of new books for the library, deeming it most prudent to keep a portion in reserve for future contingencies. During the past year the number of volumes issued has been 4,396, being a considerable increase on the issue of the year before; and there have been added during 1863, nearly a hundred volumes of popular works, and bound and repaired about 80 volumes, a great part of the expense having been defrayed out of the proceeds of a sale of *Athenæums*, *Art Journals*, and other books, not adapted for circulation. The ordinary sources of income to the Institution may be placed under three heads, viz., sale of tickets, money received from non-members on lecture nights, and sale of old newspapers; from the first of these the receipts during the year 1863 were £198 15s.; from the second £83; and from the third £4 10s. An analysis of the ticket account shows that during the year there were sold 84 at one guinea; 70 at 5s. 6d.; 81 at 4s. 6d.; 318 at 3s. 6d.; 223 at 2s. 6d.; 2 at 3s.; and 140 at 1s. 6d.; the two last of these are summer quarter tickets, the aggregate sale of which was 142, being but 71 for each quarter, and these at a very low price; by this decrease in the number of members during the non-lecture season, a heavy loss is entailed on the Institution, which only a lecture season of extraordinary success can make good. The sale of tickets admitting to lectures only has been 304, of quarterly members' tickets of all kinds, 530; making together 834; an average to each quarter of 208; adding the 84 guinea ticket holders, the result is 292, the average for the whole year. The balance sheet for 1863 shows that the receipts were £302 18s. 2d., and that there is a balance in the treasurer's hands of £27 11s. 4d.

Rotherham and Masbro' Literary and Mechanics' Institute.—The report of the past year says that the committee, having devoted their principal efforts to placing the finances of the Institution in a sound condition, and to the necessary improvements of the building, are glad to be able to report a fair measure of success. A considerable amount has been expended in rendering the building more commodious. The Lecture Hall has been decorated, and the lighting and warming improved. Arrangements have been made with the Rotherham Literary and Scientific Society to locate itself in the Institution; also with the Court of Foresters to have its meetings in the Lecture Hall. The number of the members at present is as follows:—Male subscribers, 134; female subscribers, 17; boys, 31; girls, 9. Total, 191. Lectures have not been supplied because they were not in demand to an extent that would warrant the invitations of unpaid lecturers, or guarantee the funds from considerable loss in the employment of paid ones. Pursuant to the report of the previous year, and to a resolution of the general meeting, the committee sought to initiate a movement towards the establishment of a Workmen's Club. As a first step they endeavoured to gain the co-operation of those for whose exclusive advantage the club was intended, and invited representatives from the various works in the immediate vicinity to meet them in furtherance of this object, but met with no response. Consequently nothing more was done; for although still convinced of the great utility of such institutions the committee did not feel called upon to take all the trouble and expense of an enterprise for the benefit of those who can and ought to aid them in this and all similar efforts. They venture to affirm, however, that their successors will be very ready to offer a co-operative hand to the workmen, whenever they shall awake to their true interests in this direction, and evince a desire to help themselves. In the report of the classes connected with the Institute regret is expressed at the small number of those who have availed themselves of the opportunites afforded them, and the great irregularity in attendance. The night-school for boys has had 19 names, whilst the average attendance has been barely 9; and in the girls' night-school, 2 only have attended. In the class for advanced reading there has only been an average of 6; in that of drawing, the average is 3½; in the advanced arithmetic class the average is 5½; whilst in that on the philosophy of common things, it is very little over 3. The balance-sheet shows that the expenditure of the current year had been £263 3s. 6½d., leaving a balance due to the treasurer of £13 6s. 9½d.; by the general account it was seen that the liabilities were £1,472 4s. 6d., leaving a balance against the Institute of £1,367 18s. 0½d. The transactions in the Penny Bank have considerably increased during the past year, as the following table will show:—

	Dec. 1862.	Dec. 1863.
No. of accounts opened since commencement, Oct. 1856	3347	4205
Remaining open	802	837
Number of payments	9602	10064
Average of each		8¾
Amount received	£326	£387
Amount paid	£334	£370
Amount in the Sheffield Banking Company	£186 0s. 3d.	£193 10s. 3d.

ART-WORKMANSHIP PRIZES.

Our correspondent on this subject thus resumes his remarks. He wishes to correct an error of the press in his second article, which attributed the locality of the antique group of the "Graces" to the library at Vienna; the work in question is in the library at Sienna; its origin is, he believes, unknown, but the figures are doubtless of Greek or Greco-Roman workmanship of the best period.

Before wholly quitting the subject of arabesque, as involved in the articles selected for the current competition, it is advisable to point out the distinctive differences observable in the treatment of the same, accordingly as it is applied to subjects wrought in stone, or marble, and in metal. The chair-back adopted for the first section of ornament in Class 1, Carving in Marble, Stone, or Woods seems fittest for either of the two former materials; it is certainly less suitable for reproduction in the last, *i.e.*, wood; whatever might have been the original use of this model, its whole character seems proper to stone, and from stone originals the details of its design were probably borrowed. The Gothic bracket, third section of Class 1, although, of course, derived from a stone antitype, has more than enough of the fleshiness and freedom, the *embonpoint*, as the French say, and exuberance, which are desirable and best reproduced—where reproduction in another material is allowable—in a wooden one. The student of carving in any material, who desires to examine admirable examples of decorative design and execution, will find a splendid series in the casts of Venetian sculptures—principally from the Giant's staircase and the Mocenigo palace in that city—deposited by the late Prince Consort in the South Kensington Museum, and now placed against the wall of the east cloister of the north court. Many of these examples are the work of Sansovino, the famous sculptor, and supply instances of perfect combination and design, admirably adapted to modern uses. On the whole these are the finest arabesques yet known to me. Their execution leaves nothing to be desired, and, to those who do not appreciate the productions of the great Gothic sculptors, offer perfect models. They are almost as fit for application to wood-carving as to their original material. Grace and delicacy are their characteristics. Antique arabesques require a severer order of feeling and a graver kind of training to be obtained by our people, ere full justice will be done to them by the world in general.

It would occupy too much of my space to dilate upon the subtle but apt distinctions in the treatment of arabesque, which are, to the expert, palpably existent between its use in stone and in wood. The differences which present themselves between designs proper to metal and stone are more easily defined and more to the present purpose. If the teacher takes up the arabesque designed by Lucas Van Leyden, and proposed as a model for the prize in Class 6, Etching and Engraving in Metal, or that which supplies the subject for the section of ornament in Class 7, he will find perfect arabesques proper for reproduction in metal. The Flemish salver, to be used by competitors in the second section of Class 7, Repoussé Work, offers to this end, however, by far the best example of its kind in the series before us. It has been chosen for a model with consummate knowledge, not alone of its art-value, but of the material to be employed in its reproduction. With all its grace and richness, and the splendid wave-like sweep of the lines of foliage which compose it, there is in those lines, as well in the exquisite details of the flowers and leaves of this example, a certain firmness and rigidity of form and relief which differ exceedingly from the fleshy character and rotundity of the scrolls in the chair-back, or the sculpturesque beauty of the Venetian arabesques just referred to. In the salver the very inequalities of the ground, peculiar to, and desirable in, repoussé workmanship—inasmuch as the effect of the rich colour of the metal itself is thus insured, and endless variety in the play of light upon its surface obtained—have an apt display. The ancient workman was as thoroughly aware of the advantages of the seeming roughness derived from these inequalities, as it is certain that our ordinary modern craftsman is ignorant or thoughtless of the same. The slave of his labour, and narrowly taught, the latter aims at finish before all things, and seems as if he were loth to leave his work thus apparently unfinished. Consequently upon this narrowness of view, almost all modern repoussé works look as if they were machine-made, and derive little advantage from the peculiar material employed. The producer—in the stiffness of his intense conscientiousness, fears to wrong his employer by leaving even the appearance of incompleteness upon his work. The great thing to be considered with regard to the employment of splendidly-hued metal is the display of its colour; nothing does this so perfectly as the wavy and beaten surface of a fine piece of old repoussé work in gold, silver, or brass. In stone, of course, this aid to effect is not looked for, and it is not desirable to leave the "flat" or ground of a carving in the material so uneven as it may be in repoussé work.

The graceful but extremely rigid forms of the piece of chiselled iron, which served for a model in its class in the former competition, showed an admirable application of design to a material far less tractable than the softer metals. Some of the French and German works now in the South Kensington Museum are perfect specimens of chiselled iron. In the Hotel de Cluny, Paris, are many more. The fourteenth and fifteenth centuries produced the finest examples of skill in this matter; they are to be considered as wholly distinct from engraved works on iron, and are sculptures in the true sense of the word. Much armour of the sixteenth century combines repoussé with chiselled work. In these, no less than in the greatest statues, the material has its proper form of expression; the kind of arabesque that suits production in wood differs as greatly, or should do so, from that required for the decoration of stone, leather, or metal, as the materials themselves from each other. Experts are able to detect a certain inappropriateness of design in those antique statues which have been copied from bronze originals. It is hardly too much to say that no severer censure of a work could be pronounced than to say, justly, that its style resembles that of one produced in another material. A stone house built to look, as far as is possible, like a brick one, is never satisfactory to the eye of an artist; yet, to produce something of this resemblance seems to be the object of the elaborate chamferings of the edges of building-stones in debased architecture.

I was sorry to observe that the invitation of the Society of Arts with regard to the production of works in chiselled iron—for which the above-named example in that metal was selected as the model—was responded to insufficiently. Doubtless this kind of work is nowadays little used, but it might well be re-introduced; there are ample opportunities for its use in modern domestic arrangements. The beautiful example set before competitors in Class 3, Hammered work in Iron, Brass, or Copper, needs no commendation of mine. It is a German production, dated 1700. In the South Kensington Museum are some noble specimens of English work of this kind in the gates removed from Hampton Court, and now placed in the temporary or "boiler" building. Hammered iron work is, as may be seen on examination of the specimens referred to, totally different from that which is properly styled chiselled.

The next set of examples to which I propose to refer is, that of carving in ivory. Mr. John Webb has liberally allowed the Society to use, as models, two works in his possession. One of these is an exquisite little statuette, attributed to a famous native of Flanders, who worked at Rome, and is known by the name of François Flamand, surnamed Fiamingo; his true name was François Du Quesnoy. He was born in 1594, and of all the minor sculptors of modern times he is probably the best known. A considerable number of boys, in all varities of spirited actions, and in many that represent sleep, are attributed to him. Few excel the one before us in beauty, faithful design, and delicate execution. The naturalism of the 16th century did its best in the latter. The little fellow lies upon his back, one arm is thrown above his head, the other lies by his side, relaxed in complete repose, one leg is crossed over the other. The face is charmingly pretty, and nothing can exceed the freshness and elaboration of the body and limbs. Few sculptors of any age have been so successful as Fiamingo in treating the full and rounded forms of early childhood. It is worth noting how ably the artist has, in the work now in question, given the naturally characteristic proportions of the human form at the period of infancy; the body, as that part of the frame which is most in use to supply the limbs with the materials for development, is then far greater in proportion to the others than at any other stage of existence. His legs are hardly to be considered as locomotive organs; the head is comparatively immense; the chest undeveloped, because no great vitality has yet to be sustained by rapid breathing; and physical exercise has not yet called upon the lungs to perform their office to the full; the arms are almost as subordinate as the legs. The baby sleeps that it may grow. The surface of the model is exquisitely wrought; I need hardly point out how lovely are the forms of the elbows, especially where the bones of the fore-arm are cunningly indicated through the soft and almost pulpy flesh. The markings on the chest deserve heedful attention.

The second example to be employed for ivory carving has great beauty of its peculiar kind. A singular interest attaches to the history of works of its class. The models in question are the two covers of a tablet, carved in *mezzo-relievo* with the figures of females, which may, for want of better titles, be said to represent War and Peace. Each is enclosed by a sort of tabernacle, such as was so common in Italian works of the later half of the 15th and the 16th centuries. In each, two columns support canopies of different character; the figures stand upon flat bases, which have arabesques delicately wrought upon their fronts. The works are probably Italian or French, and of about the beginning of the 16th century. They formed the covers of a tablet which might have contained wax, and was used as a sort of note-book, the soft surface of the wax being written upon with a silver, ivory, or gold point or stylus. Such things had been in use among the ancient Romans, and we find Martial and Juvenal, in the age of Augustus, referring to their employment in various ways and to their having been given by friends as keepsakes. At a later date such articles were distributed somewhat in the fashion of our times, when a member of Parliament gives to his best supporters at an election lithographed portraits of himself. This class of works forms one of the most important and historically interesting sections of minor Roman sculptures which has come down to us. The articles were sometimes styled *pugillares*, because they were carried in the fist or hand. Bribery and corruption of electors took effect by means of them; and so late as the fifth century after Christ we find the Emperors prohibiting such gifts by any but officials of the highest rank.

A noble subject has been given for a model to the class of chasing in bronze, the section of the figure, by a machine-reduced cast from the well-known antique Roman bust generally styled "Clytie," but also recognised by the name of "Isis." This sculpture represents the features and the form of some long-dead lady, it may be an empress, and, independently of its artistic value, offers some curious points for our consideration. Judging from its style it would seem to have been executed in the first century of our era, and to be the work rather of a Roman or Alexandrian sculptor, than one of those Greeks who were settled in Rome, or whose works were imported to that city. Beyond all question it is a portrait, somewhat idealized in treatment, but still preserving all the character of a likeness. After the Roman fashion the hair grows low upon the forehead, is parted in the middle, and flows in crisped waves, to be gathered at the back of the head and drop its ends upon the neck. The surface of the marble is perfect, and its fleshy treatment offers to reproducers a beautiful though not severe model. Its names of "Clytie" or "Isis" are respectively adopted by those who accept the petal of a flower from which the bust issues, either as those of the sun-flower—into which Clytie, the nymph who loved Apollo was turned (whose love compelled her, when transformed, to follow with her face the daily course of the god), or of a lotus, the flower that was sacred to the Egyptian goddess Isis. It is nevertheless simply a portrait in character. I do not know where it was discovered, but the original is now in the British Museum—where I beg competitors to study it—numbered 79, and was originally part of the famous Towneley collection. Towneley bought it at Naples of the Laurenzano family, and set so great a store by it that—when he conceived his house to be in danger from the "No Popery" mob of Lord George Gordon's Riot, 1780—he chose it, of all the treasures he possessed, to be removed out of harm's way by himself, in his own carriage.

THE BRADFIELD RESERVOIR.

The following is from a correspondent:—

There are two or three points which attracted my attention on visiting the broken embankment at Bradfield, and the first was, that the place was not suited for the formation of a reservoir at all, on account of the absence of a position on which a good retaining embankment could be built. It is at all times difficult to obtain a water-tight junction between clay and rock, and this circumstance has already given great trouble in forming embankments, as in the case of Doe-park Reservoir, near Bradford, where the ends of the puddle wall had to be turned and carried up the interior slopes of the reservoir until the clay gradually merged into a stiff argillaceous soil. How much more, then, was it a difficulty at Bradfield, where the puddle had to be abutted on a loose porous sandstone, alternated with layers of friable shale?

The difficulty of obtaining a proper, sound foundation for the embankment, more especially for that part of it which was composed of puddle, gave rise to one of the weakest points in the Bradfield Reservoir. The materials used in the construction of this work have been largely abused, but I think that their inferiority has never been exaggerated.

A mixture of large stones, about one cubic foot in size, and masses of the porous shale obtained from the slope of the valley, seem to have been aggregated together in the rudest manner possible. It would be easy to understand why this mass, used as the material for construction, wanted uniformity in its composition, if, as is said, it was similar to that used in the Ogden Bank. There the materials are certainly the same, and were being heaped up to form a bank, about the time of the inundation, by means of "tips," some being placed about fifteen feet high, near the centre of the bank.

Not only is it impossible that a bank constructed in this way can settle equally, but the very mode of making it, viz., 'tipping' the material from either end, and gradually approaching the centre, renders the section at this part the weakest of all. And it is to be noticed that it was at this part of the Bradfield Dam that the rupture took place. So porous did the bank seem that there can be little doubt that the water could easily ooze through it, saturating it and bringing upon the inside of the puddle wall almost the entire pressure of the water stored in the reservoir. This appears to be corroborated by the fact that near the top of the inside slope of one of the parts still standing there is a longitudinal depression, increasing in depth towards the gap, and indicating that when the bank gave way the water in the inner half was drained off from the two ends towards the centre, carrying with it part of the material, thus causing the subsidence referred to. The puddle also, though in some cases good, appeared to be occasionally not quite free from shale; coupled with which, the outlet pipes were carried in a very loose way through the materials spoken of.

It is difficult to determine, after the accident, which of all these weak points was the proximate cause of the failure of the dam, but it is probable that it occurred in some such way as the following:—

It has already been said that, up to the puddle wall, the bank must have been saturated, which would cause a subsidence of material to fill the interstices, and bring on every point of the wall particles of water, having a pressure corresponding to their depth, and searching for means of escape through the bank. This means the water appears at last to have found, either through a slight fissure caused by unequal subsidence, or most probably along the outside of the outlet pipes. Having once got to the other side of the wall, a similar subsidence would have been formed on the outside of the bank. In this way the first crack, probably, originated. The settlement on each side, then, would leave the top of the puddle wall unsupported to any extent, and it is easy to understand how the wave-force of the water would overturn the top of the puddle, and break it transversely. According to all accounts, the waves on the dam, at the time of its bursting, resembled those of the sea, and broke against the bank with such force that the spray rose high above the top of the embankment. When the water had thus acquired a passage over the ridge of the bank, it rapidly destroyed the outside, and cut its way down to the bottom of the gap. Once through this, its velocity increased with fearful rapidity—it carried destruction for many miles—accounts of which we have all read with horror.

Such, perhaps, was the manner in which the Bradfield accident occurred, and this would show the necessity of making a reservoir embankment water-tight altogether, and of protecting it from the action of waves by means of traverses built in the dam.

Fine Arts.

Market Price of Works of Art in France.—The enormous prices which have of late been obtained in Paris for pictures and other works of art have given rise to much discussion, and to many comparisons with the results of the sales of former times. It is difficult to establish an exact table of the fluctuations in such matters, for more reasons than one; in the first place, there is the diminished value of money to be taken into account, and, in the second, the comparison must often be made not on the same picture, but on pictures of the same class by the same master, between a special case on the one hand and the average prices on the other; or, lastly, between the average prices at the various periods. Still, allowing for all the difficulties and the amount of uncertainty resulting from them, the increasing value of pictures is so marked, and, with some exceptions, regular in its course, that it furnishes a very curious study from more than one point of view. At the Sireul sale, in 1781, a charming portrait of the Marquise de Pompadour, in pastels, by Boucher, sold for 900 francs; at the same sale an admirable picture by Terburg went for 702 francs. In the following year the "Serinette Player" of Chardin was knocked down, at the sale of the pictures of the Marquis de Menars, at 631 francs; and three portraits of Louis XIV., at different ages, enamels, by Petitot, with chased gold frames, only fetched 399 livres and 19 sols. At the Lancret sale, in the same year, the best pictures by the deceased artist fetched only 201, 250, and 112 livres respectively, and another only 19 livres or francs. In the same year, at the Nogaret sale, Rembrandt's "Good Samaritan" was bought for 900 francs, while not long since an artist's proof of the engraving of the same picture, by the painter himself, fetched 2,400 francs. An excellent picture by Watteau was allowed to go for 200 francs, at the Bélisard sale, in 1783; and at the Lebrun sale, in 1791, Holbein's large picture of the "Court of Francis II.," went for 40 francs; Poussin's "Alexander and Diogenes," for 240 francs; and a bronze statuette of a "Woman Bathing," by Jean Goujon, now worth at least its weight in gold, 20 francs! In 1797, a good picture, by Lesueur, sold for 161 francs; and two works of Lancret, for 84 francs! In 1801, the picture of Gonzalès Coques, which at the Patureau sale fetched 45,000 francs, could not find a purchaser to bid more than 3,000 francs at the Robit sale. In 1803 the portrait of the Burgomaster Six, by Rembrandt, was sold publicly for 1,310 francs; and one of Clodion's charming terracottas for 150 francs. In 1809, a charming picture, by Watteau, four characters in Italian comedy, was only valued at 70 francs; and in the following year a fine portrait of "A Lady," by Vandyck, went for 481 francs. The following table, exhibiting the maximum price obtained for the *chefs d'œuvre* of Hobbema, will illustrate the rising of the scale in a still more striking manner:—

1789	300 livres	Tronchin	sale.
1802	4,200 francs	Helslenter	„
1808	1.399 „	Robert	„
1809	850fr., 1200fr., 532fr.,	Schwanberg	„
1810	119fr. 95c.	D'Orsay	„
1812	1,000 francs	Villers	„
1814	2,400 „	Paillet	„
1817	7,100 „	Lapeyrière	„
1821	11,900 „	Lafontaine	„
1832	7,210 „	Erard	„
1841	30,000 „	Heris	„
„	23.000 „	Perrégaux	„
1850	27,000 florins	Guillaume II.	„
1852	72,000 francs	De Morny	„
1857	96,000 „	Patureau	„

At the last-named sale the "Two Cousins," by Watteau, realised no less than 55,000 francs! The value of china, and other objects of art or curiosity, has kept pace with that of pictures and sculpture; in fact, in the case of Rouen, Nevers, Palissy, and other wares of that class, and of Limoges enamel, the increase has been even greater than that which has taken place with respect to pictures. In many cases the lapse of half a century or more has naturally increased the value of the object, but this will not account for the tithe of the difference between old and present prices.

International Exchange of Copies of Works of Fine Art.—The committee of the Council of Education have lately approved of the following memorandum on the International Exchange of Copies of Works of Fine Art.—1. The collections at South Kensington now possess many examples of works of fine art executed in various kinds of materials which are unique for their beauty, excellence, and rarity. 2. In like manner most of the Art Museums of the Continent contain similar works. 3. Such objects must always remain permanently as national treasures of the respective country possessing them. 4. Although the originals cannot be acquired, various modes of reproduction are now matured and employed, such as electrotyping, photography, elastic moulding, &c., whereby admirable substitutes may be easily obtained with perfect security to the originals. 5. The important National Art Museums at Paris, Berlin, Dresden, Munich, &c., already possess plaster casts of ancient marbles, representing originals which are not in their own possession. But no comprehensive system appears yet to have been matured of employing electrotyping or photography to obtain copies of objects. 6. A commencement of issuing duplicates of fine objects useful in general art instruction, however, has been made by the South Kensington Museum. For example, through the intervention of His Royal Highness the Prince Consort, copies have been obtained of the numerous works of fine art in the possession of Her Majesty the Queen. Through the liberality of His Majesty the Emperor of the French, the Science and Art Department was enabled, in 1855, during the Paris Exhibition, to obtain electrotypes and photographs of numerous objects in the Louvre and Musée d'Artillerie, at Paris. Photographs also have been taken of the most important objects, which for public instruction and gratification were so liberally lent to the Department by private proprietors during the International Exhibition of 1862. The University of Oxford has unreservedly permitted photographs to be taken of its original drawings by Michael Angelo and Raffaelle. Arrangements now exist at the South Kensington Museum by which every object of the art collections may be copied by some one of the many processes. 7. The period, therefore, seems to have arrived when friendly relations might with reciprocal advantages be established between foreign museums and the South Kensington Museum for the purpose of organizing some system of international exchange of copies of the finest works of art which each museum possesses, through Her Majesty's Secretary of State for Foreign Affairs, by correspondence with the governments of the various countries which possess museums and works of art. 8. The accompanying art inventory of the South Kensington Museum shows the nature of the objects already the property of the Museum. Many objects of exceptional beauty and rarity might be copied, and the nature of the copies has been indicated in the inventory. These might be deemed worthy of the acceptance of the museums of other countries. At the same time it may be observed that every object named in the inventory might be copied if desired. 9. A copy of this catalogue should be forwarded to Her Majesty's Ministers abroad, through the Foreign Office, to be delivered to the various governments. A request should be made to such governments to forward to the South Kensington Museum any printed or MS. catalogues of their own museums in which the objects, excellent and rare, might be denoted in a similar way. Opportunity might be taken to inquire if the respective governments would be disposed to entertain the idea of an exchange of copies of objects, and, if they should concur in the idea, to ask them to authorize the various Directors of Museums to communicate directly with the Lords of the Committee of Council on Education, at the South Kensington Museum. Copies have been sent to the British Ministers abroad.

Manufactures.

THE PRESENT STATE OF KNOWLEDGE IN REGARD TO GUN-COTTON.

At a time when the chief nations of the civilised world are occupied in experimenting on the arts of attack and defence, it will be considered neither uninstructive nor uninteresting to the scientific world, to consider the state of knowledge in regard to what may become one of the most powerful engines in human warfare.

The discovery by Schönbein, in 1846, of pyroxylin, or gun-cotton, was predicted by Pelouze in 1838, who found that cotton, hemp, linen, paper, &c., when immersed for some minutes in nitric acid, and then well washed, became substances of great combustibility. In the brief history of the substance, various have been the changes to which it has been subjected in scientific and professional opinion on the practicability of its application to warlike purposes. From time to time, certain acquired knowledge has brought to light the various properties of gun-cotton, known under the names of pyroxylin, nitro-cellulose, &c., but since the report of the French Commission, the record of whose experiments was published in 1852, and whose decisive verdict was that, "Dans l'état actuel, il n'y a pas lieu de continuer les expériences au point de vue de leur emploi dans les armes de guerre," the subject may be considered to have been set aside until within very lately.

The revival of the question may be fairly attributed to the increased attention paid by scientific and military men to the arts of war in all countries, and to the labours of continental chemists, the latter being evidenced in the report of June, 1863, on Baron Lenk's gun-cotton, presented to the President of the Austrian Imperial Commission on Gun-cotton.

The method pursued by Schönbein was to steep finely divided ligneous matter, as cotton-wool, for a few minutes in a mixture of nitric acid and concentrated sulphuric acid, afterwards squeezing, washing, and drying it; this substance being found to ignite at about 400° F. or even lower. Gun-cotton has, however, been manufactured by various persons by acting on cotton with mixtures of nitrate of potash and sulphuric acid, but these processes have been so varied in detail as to result in an infinity of substances known under the general name of gun-cotton.

The usual preparation of gun-cotton is by the mixture of three volumes of nitric acid with five volumes of concentrated sulphuric acid; this mixture having been allowed to cool, the dry cotton is immersed by degrees in the fluid, remaining therein 15 or 20 minutes; it is then compressed, freely washed, and dried by cloths, or a current of air at a temperature of 90° F. The reaction of the nitric acid on the cellular substance of woody fibre may be stated in the following equation:—

$$C_{24}H_{20}O_{20}+5\,(NO_5HO)=8\,HO+\overbrace{C_{24}H_{17}O_{17}+5\,NO_5}^{\text{Gun-cotton.}}$$

The explosive force of gun-cotton manufactured in the manner above described being much greater than that of gunpowder, the instantaneous strain is too great for the metal of the gun to withstand, and hence one of the reasons for the non-substitution of gun-cotton for gunpowder.

The objections to the use of gun-cotton thus manufactured may be briefly stated. Firstly, the low temperature at which it explodes, 400° F. and even lower. Secondly, its facility of explosion by percussion. Thirdly, the aqueous character of its products after explosion. Fourthly, rapidity of explosion. Fifthly, its liability to spontaneous explosion, and the production of gelatinous matter.

Its advantages consist in the obvious facilities of packing, transport, and employment, besides its compressibility and its not being injured by exposure to the action of water. The fact of carbonic oxide, one of the chief products of its combustion, being a poisonous and inflammable gas, has prevented gun-cotton from being used in military mining when galleries are used in the operations. A remedy has been proposed by combining gun-cotton with nitrate of potash, by which carbon is changed into carbonic acid, the other chief products being nitrogen and water.

The experiments of Baron Lenk, at Hirtenberg, have occupied many years, and although we are not warranted in accepting every statement which has been made with reference to the gun-cotton manufactured by him, it is right that we should admit the advance in knowledge which has attended his assiduous researches upon this subject. The Austrian Commission has proved, at least as far as its conclusions go, that one part of gun-cotton is equivalent to three parts of gunpowder, and that, as prepared by Baron Lenk, it is more uniform in explosion. The process, as far as we understand it in this country, is as follows:—Cotton yarn twisted into strands is steeped for a few minutes in nitric acid and washed; it is then left for forty-eight hours in a bath containing equal volumes of sulphuric and nitric acids After being squeezed it is exposed from four to eight weeks in a stream of water, and then dried and finally soaked in a boiling solution of potash in order to render it slower of combustion, and non-explosive by percussion. The distinguished chemists, who report upon Baron Lenk's gun-cotton, argue that in consequence of the difference of detail in the processes of the experimenters upon the subject, but little value can be attached to the past experience of gun cotton. The variations in detail may be stated to be variations as to strength of acids, temperature, duration of chemical action, removal of free acid, and conditions of mixing. When we consider the little which has been done in this country on the subject, it is consolatory to know that the French Commission, after six years' labour, failed to arrive at any definite result, and, according to the Austrian report, neglected not only to ascertain the true composition of gun-cotton, but also whether the substance upon which it experimented was the same, in a chemical point of view, all through the series. It is certainly fair to insist upon the fact, that the method of preparation in the French experiments is very different to that employed by the Austrian Commission. In the analysis of the Lenk gun-cotton by the Austrian Imperial Engineers' Committee in 1861, it is shown that it is almost entirely composed of tri-nitro cellulose, while it should also be stated that experiments in this country do not agree in the importance attached by General Lenk to his treatment of gun-cotton with soluble glass. With reference to the statement made in the report, complaining that if a comparison be instituted between gunpowder and gun-cotton, then the difference in the true composition of the charcoal used should be appreciated, it is sufficient to reply that in this country, at all events, the preparation of wood-charcoal for the manufacture of gunpowder is conducted in such a manner and by such a process as to ensure a high degree of uniformity, and that the manufacture of gunpowder, so far from being in the hands of ignorant persons, as is stated by the report to be the case in Austria, has almost attained with us a climax of scientific ingenuity and accuracy.

Notwithstanding the assumptions and arguments used in the report with regard to the unalterable quality of the Lenk gun-cotton, and also a statement to the effect that a quantity of cotton was exposed, after lying in a pond for six weeks, to a stream of water, then to the air for one month, and failed to redden litmus paper, it is considered that proof has been obtained by experiments carried on in this country that an acidity will become manifest in the Hirtenberg gun-cotton during the drying process, and that this acidity remains after storing in wooden or metal-lined cases, even if these are kept ventilated. It is possible that higher nitro-compounds, which exist in minute quantities in Lenk's gun-cotton, are decomposed, and the acid observed—the result of their change—while there is ground for believing the *tri-nitro cellulose* to possess greater stability. The apparent argument that the acidity observed in stored gun-cotton is of no more value than the minute changes which occur in gunpowder, is not to be entertained for an instant, because the evolution of heat in the case of gun-cotton is far greater than in that of gunpowder, and sufficient to lead to the ignition of the material. The statements which the Austrian chemists make in regard to the unfitness for ballistic purposes of gunpowder which has been exposed to the action of the atmosphere, are sufficiently contradicted by Mr. Abel, the chemist to the War Department, of all persons the most experienced on such a subject. In the report of Lieut.-Colonel Baron Von Ebner, the lowest explosive temperature of the Hirtenberg cotton is fixed at 276° Fahr., but there is nothing contained in the Austrian report which can be admitted to support the assertion that the cotton is not spontaneously explosive, while it is fair on the other hand to publish the fact, that only one seemingly spontaneous explosion of Hirtenberg cotton has occurred in ten years. There can be no doubt that the assertion in regard to the safety of the process employed at Hirtenberg is perfectly correct, and that as the material acted upon is in a moist or wet condition during the operations, it is of course non-explosive. In the magazine at Hirtenberg not one explosion has occurred in the space of twelve years, while there has been only one explosion in the manufactory, and that resulting from improper speed in the working of the machinery. The theoretical proofs offered in the report against the spontaneous explodibility of the gun-cotton are, that the atoms of hydrogen, which in ordinary cotton are acted upon by the atmospheric oxygen—heat being generated—are disposed of by "azotization," that by the long acid-steeping nothing remains for the oxygen of the air to act upon, and, finally, that slow decay cannot affect the gun-cotton. The *force brisante*, or *vis viva*, of gun-cotton being far greater than that of gunpowder, it follows that the strain upon the metal of a gun is proportionately increased, and hence greater danger of bursting. The proposal in this report to construct guns specially adapted to bear the enormous strain of the explosion of gun-cotton, will be received with considerable caution in this country, a feeling which the obvious fact of the greater amount of heat generated, and consequent action upon the metal, will not tend to remove. It is stated, however, that the oxidation of the metal of the gun—if there be any—will be less than that of gunpowder, when the products of the combustion of gun-cotton are considered.

The following analysis was made by Lieut. Von Karolyi, in the Chemical Laboratory of the Engineer Corps Committee:—

Gases of Combustion.

	Volume per cent.
Nitrogen	12·67
Carbonic acid	20·82
Carbonic oxide	28·95
Hydrogen	3·16
Marsh gas	7·24
Carbon	1·82
Aqueous vapour	25·34
	100·00

Whether it might not be possible to employ elongated cartridges of gun-cotton for artillery purposes, thereby spreading over a greater surface the instantaneous explosive force, is a question worthy of consideration by practical men. The gases of both gunpowder and gun-cotton are irrespirable, but it may be safely asserted on the side of gun-cotton that the gases produced being lighter, and not containing the solid particles of sulphide of potassium, as is the case with gunpowder, are more easily removable by ventilation. A consideration of the report induces attention to the following chief statements:—That the Lenk gun-cotton almost entirely consists of nitro-cellulose, and as manufactured at Hirtenberg, one invariable product results. That it is not subject to notable alteration, nor is it prone to explode spontaneously. That the temperature of ignition is sufficiently high to remove fears regarding its ordinary usage. That the *force brisante* can be moderated; this latter statement, however, requiring full experimental investigation, and that the dangers in military mining from the irrespirable nature of the product of the combustion, are fully as great in gunpowder as in gun-cotton. It is scarcely necessary to add that these assertions can only be accepted with reservation, and that it is to be hoped the attention of chemists and military men will be turned to a searching and rigid examination of their truth, with a view to our further enlightenment on so important a subject.

A New Gun has recently been invented by Mr. James Mackay, of Liverpool. The principle in all rifled cannon appears to have been to allow as little windage as possible, and to make the shot fit the grooves of the piece, taking from them a rotation in its flight. Mr. Mackay, on the other hand, has conceived the plan of having the grooves so arranged that, while the shot fits closely to their outer edge, the grooves are left open for windage. By this arrangement the gas has to travel some feet further than the shot, and in doing this is said to impart a rapid and perfect "spin" to it. The shot are of cylindrical form, smooth, with conical heads, and cupped at the other end in proportion. Mr. Mackay also claims a peculiarity in the wadding, which is of sawdust, and at the movement of the first ignition of the powder the elasticity of the wadding moves forward the shot slightly; the effect is that the whole of the powder is stated to be burnt, and the shock on the breech of the gun is considerably lessened. A gun on this principle has been made by the Mersey Steel and Iron Works Company. It is of wrought iron, weighs nine tons, has a bore of 8·12 inches, and in other respects corresponds with the general features of the ordinary 68-pounder. There are 12 grooves, and, as the shot do not enter these grooves, it allows of a much sharper twist than in ordinary rifled guns. The velocity has been found to be 1,640 feet a second. Messrs. Laird and Company, of Birkenhead, are now building an armour-plated vessel called the Agincourt, for the Government, and the gun has been tested against a section of the side of that vessel. This target consisted of an outer plate, 7 feet square and 5½ inches thick, of rolled iron; next came 9 inches of teak, then an inner plate or skin three-fourths of an inch thick, then angle iron and ribbing, and finally a backing up with timber balks and supports 18 inches thick. The gun was charged with 30 lb. of powder and a cast steel shot, weighing 167 lb. The range was 200 yards. At the point of impact a perfectly circular hole was cut. The shot then powdered the teak, passed through the inner skin and the angle iron, shattered the timber balk, and was picked up 82 yards beyond the target, together with a circular piece of the iron armour, about 80 lbs. weight, it had carried with it through the back supports. The sand showed that it had spun to the last. The shot when found was reduced from 13 inches to 11 inches in length, and increased about an inch and a half in diameter at the end which struck the target. The other end was uninjured. The whole target was forced back about six inches, and so much deranged that more shots were not fired.

Copper Mining in Lake Superior.—The total amount of capital invested in the fee-simple and development of the mines now working, not including the value of the metal produced, is estimated at about 6,000,000 dollars, while their stocks are worth over 15,000,000 dollars. The aggregate amount of copper produced in 1863 was not less than 9,000 tons of stamp work, barrel and mass, or about 7,500 tons of ingot, worth at its present value over 6,000,000 dollars, or the total sum of money thus actually invested; but as the largest portion of it was probably sold at an average of 35 cents. per lb., the aggregate receipts of sales will not be much over 5,000,000 dollars, from which about 1,000,000 dollars has been, or will be, divided among the shareholders, with still full treasuries, so far as most of the mines are concerned.

Production of Oxygen Gas.—In a paper read before the Pharmaceutical Society a short time since, Mr. Robbins described a new, scientific, and cheap method of producing oxygen gas. After adverting to the various methods hitherto employed, he says:—"It will have doubtless been observed by you that in all the processes hitherto known a high temperature is necessary, and until that point is reached, no product whatever is obtained; this fact we may consider as the chief difficulty experienced in the preparation of oxygen, and more especially so when sulphuric acid is used. If, for example, by the mere addition of sulphuric acid to bichromate of potash in the cold we could get the same results which are obtained by the application of heat, this process, instead of being thrown in the rear, would have taken front rank. Oxygennesis therefore stands alone as a novel and the only mode we possess for producing oxygen without the application of heat. The mode of using this compound is extremely simple. We have only to take some of this powder, place it in a glass flask or bottle provided with an exit tube, pour on either of the dilute mineral acids, and we have immediately oxygen evolved in a similar way, and with as much facility as hydrogen is obtained from zinc, or carbonic acid from a carbonate. The composition of this compound is extremely simple, *merely* a mixture of peroxide of barium and bichromate of potash; not so the chemical changes resulting from the addition of an acid. Peroxide of barium on addition of sulphuric acid is resolved into sulphate of baryta and peroxide of hydrogen, and it is from this sometimes so-called oxygenated water we get this curious and interesting chemical reaction. Whenever peroxide of hydrogen and chromic acid are brought in contact with each other, instantaneous decomposition is the result; the chromic acid is reduced to sesquioxide of chromium, and the peroxide of hydrogen to water, at the same time pure oxygen derived from both those substances is disengaged. * * * * We are not compelled to use precisely the ingredients mentioned, but may substitute analogous compounds. Peroxide of barium might be replaced by any other peroxide capable of forming binoxide of hydrogen, of which there are several,—peroxide of potassium, sodium, strontium, and calcium, but all these at the present time are practically useless, peroxide of barium being the only one that can be easily and cheaply prepared. Bichromate of potash may be substituted by manganate or permanganate of potash, binoxide of manganese, or binoxide of lead; the cost of the two first-mentioned forbids their present use, and the one selected is by far preferable to the others. With regard to the acids, either of the mineral class will do, but I prefer sulphuric acid. The next question demanding our notice is, in a commercial point of view, a most important one; however much this method may be admired for its simplicity, and the ease with which the operation may be conducted, its ultimate success or failure must depend on the cost. Can the oxygennesis therefore be manufactured and sold at a price sufficiently low to make it an article of commerce? I believe it can be made available for all purposes whenever oxygen is required to the extent of some gallons. One of the ingredients of this compound, peroxide of barium, has never yet been produced and sold as a commercial article, and from the trouble in making a small quantity, but few, even practical chemists, care to prepare it for themselves. It can hardly therefore be expected that a compound of this nature can at once be manufactured and sold at a price it must ultimately be reduced to, if extensively used and produced in quantity. Five shillings per pound, the price hitherto charged, would, I admit, be a barrier to its general adoption; but I am happy to say we have now made the necessary arrangements to lessen the cost of production, and have at the same time reduced the price to three shillings for the one-pound bottle, and less if a larger quantity is required. Some of the baryta compounds are found abundantly in nature, and are but of small value in the market, but up to the present time but few uses have been made of them; they now promise a much more extensive application. Mr. Kuhlman has perhaps done more than any one else to develope their uses and value in the arts."

The Michigan Petroleum, lately discovered, has been analyzed, and found to be of a very superior quality. It is said to have less odour than the crude Pennsylvania oils, and will yield 20 per cent. more of the refined article than the former. Its specific gravity is 40 deg. That of the Pennsylvania oil ranges from 45 deg. to 47 deg.

Colonies.

Machine for Ship Pumping.—A Hobart-town paper speaks of a new machine (the invention of Capt. Christie) for working the pumps of a ship in the event of her making a large quantity of water. The machine is on the principle of a child's roundabout, but where the horses are placed in that apparatus masts are fixed in this, which are six in number; sails are attached, so arranged that three must always be full of wind whatever direction it may blow, the other three being edge on and consequently powerless. A strong motive power is stated to be thus obtained, which causes the centre shaft to revolve, and this in turn works cranks communicating with the pumps. The machine can be constructed easily out of such materials as are ever to be found on board a loaded ship. Capt. Christie also thinks of applying his idea for the purpose of raising water on the farm for irrigating.

Canadian Finance.—The public accounts for the year 1863 exhibit a more favourable balance than has been the case for several years past. The five great sources of revenue—customs, excise, public works, post-office, and territorial revenue—have produced 7,662,490 dollars, which exceed the receipts from the same sources in 1862 by 1,104,961 dollars; the minor revenues of the consolidated fund have realised 914,821 dollars, being an increase upon 1862 of 119,335 dollars; and the receipt of the trust funds and other open accounts have been 1,183,004 dollars, which is an increase of 127,575 dollars. While the revenue has thus increased in the aggregate 1,351,871 dollars, there has been a diminution of expenditure to the extent of 228,873 dollars, making a total of 1,580,745 dollars; but in spite of this great improvement upon 1862 there is still a serious deficiency, although very much less than was estimated. The expenditure, less redemption of debt, has been 10,742,807 dollars, the receipts, less sale of debentures and sinking fund, 9,760,816 dollars, leaving a deficiency of 982,941 dollars. Large as is the deficiency in this balance sheet, it is an immense improvement on the deficits of the last ten years. Of the deficit more than half is accounted for by extra militia expenditure and extra legislative expenditure.

Jamaica Cotton.—The reports from the cotton fields belonging to the Jamaica Cotton Company say that things are there looking very well. There are well established and bearing fields of 350 acres out of 560 acres first put in, from which, with average weather for gathering in the crops, shipments should be made this year, at different periods, of 350 bales of good marketable cotton. The district is well supplied with labour. The sugar planter is equally as anxious as the cotton grower for the successful cultivation of cotton in the district.

Electric Telegraphs in New Zealand.—£150,000 has been set apart by the General Assembly from the £3,000,000 loan lately sanctioned, for the purposes of telegraphic communication, and £75,000 has been allotted for telegraph works to be carried out within a period extending to March, 1865. The first portion of the main trunk line is now nearly completed, and messages will shortly be transmitted along that section.

New Zealand.—A Lyttelton paper says:—"Canterbury is a noble estate. Let a little capital and a little labour be properly expended upon the soil, and every acre rises steadily to at least ten times its original value. If it could be clearly explained in England that all who came to Canterbury became at once on landing joint proprietors in a valuable estate, valued at some ten million sterling, we cannot doubt for an instant that a large and sustained immigration would spontaneously spring up. The people of Canterbury may well hug themselves on the value of the possession which has fallen to them. Scarcely a tithe of their inheritance has been realised, and already they can point to well-made roads stretching far into the plains, to rivers bridged over here and there, to innumerable creeks made passable, to cities cleansed and beautified, and, more important than all, to a commencement of a system of railways. Long before the last acre of Canterbury has been disposed of, it may be made a thickly-peopled, settled, cultivated land, intersected with railways and telegraphs, its rivers bridged, its towns connected with the principal city, and that city connected with a port furnished with all that is needed to make it a perfect harbour. Nothing has been done towards forwarding the harbour works at Lyttelton, or extending the railway system, or bridging the rivers. If the country means to have these works carried out it must stir itself up and insist upon proper steps being taken. Every one knows that the continuation of the land sales depends upon the opening up of the country, and that the rivers that intersect the plains offer most serious obstacles to this object being carried out."

Shipbuilding in New Zealand.—This branch of trade is securely establishing itself in this colony. Eight shipwrights have arrived by the *City of Dunedin*, and immediately found employment at the yard of Mr. J.

Wilson, who has two vessels on the stocks and a large punt nearly ready to launch. At another yard a schooner has been recently launched.

Publications Issued.

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Elements of Physics, or Natural Philosophy, written for general use in plain or non-technical language. By Neil Arnot, M.D., F.R.S. Sixth edition, thoroughly revised, and containing in the second part (to be published in October next, price 10s. 6d.) the new completing chapters on Electricity and Astronomy, with an outline of Popular Mathematics. Part 1. 8vo. pp. 430, price 10s. 6d. cloth. (*Longmans.*) In the preface the author explains that after publishing the first volume and half of this work, successive editions of the unfinished book were rapidly called for, but that after the fifth he would not print it again until he should be able to complete it to his satisfaction. In the meantime, besides his direct professional business, he could not avoid giving assistance in some parts of the public service where it was requested—as by the General Board of Health in regard to sanitary affairs, and when the government honoured him by appointing him a Member of the Senate of the New University of London. Such engagements have delayed the completion of this work, until by withdrawing from professional labours, as now, he has full command of his time. In the introduction the author says, in relation to physics, "In the course of the preceding disquisition, we have seen that physics or natural philosophy, the subject of the present volume, is fundamental to the other parts of science, and is therefore that of which a certain amount of knowledge is indispensable in a sound education. Bacon truly calls it 'the root of the sciences and arts. That its importance has not been marked by the place which it has held in common plans of education is owing chiefly to the misconception that deep knowledge of technical mathematics, which only a few have leisure to acquire, was only a necessary preliminary." In relation to mathematics he says, "Now it is true that a certain amount of mathematical knowledge is necessary to the student, but it is equally true that the mathematical knowledge acquired by individuals generally, in the common experience of early years, is sufficient to enable students, with a little help, to comprehend the fundamental laws of nature; nearly as the knowledge of language obtained at the same time and in the same way is sufficient, without the previous study of abstract grammar, to enable persons to understand conversation on all common subjects. Few persons in civilised society are so ignorant as not to know that a square has four equal sides, and four equal corners or angles, that every point in the circumference of a circle is at the same distance from the centre, or who do not immediately discover whether a tree or pillar observed stands upright or leans, whether a table is level or inclined, whether two lines are parallel or not, and so forth. Now these are fundamental mathematical perceptions, and it will be shown in the mathematical appendix to this work that such truths reach far in explaining the great phenomena of nature." In relation to the importance of physics to medical practitioners, he says, "Physics is also an important foundation of the healing art. The medical man, indeed, is the engineer pre-eminently; for it is in the animal body that the highest perfection and the greatest variety of mechanism are found. Where, to illustrate mechanics, is to be seen a system of levers and hinges, and moving parts, like the limbs of an animal body; where such an hydraulic apparatus as in the heart and blood-vessels; such a pneumatic apparatus as in the breathing chest; such acoustic apparatus as in the ear and larynx; such an optical instrument as in the eye; in a word, such variety and perfection as in the whole of the visible anatomy? All these structures, then, the medical man should understand, as a watchmaker knows the parts of a time-piece which he is entrusted to repair." And in relation to the importance of physics to persons generally, he says, "The laws of physics having an influence so extensive as appears from these paragraphs, it need not excite surprise that all classes of society are at last discovering the deep interest they have to understand them. The lawyer finds that in many of the causes tried in his courts, an appeal must be made to physics,—as in cases of disputed inventions; accidents in navigation, and travelling; disputes respecting steam-engines, and machines generally; questions arising out of the agency of winds, rains, water-currents, &c.: the statesman in Parliament is constantly listening to discussions respecting bridges, roads, canals, docks, telegraphs, and the mechanical industry of the nation; the clergyman finds everywhere among the facts of nature the most intelligible and striking proofs of God's wisdom and goodness; the sailor in his ship has to deal with one of the most admirable machines in existence; and soldiers, while studying how to defend their country, find its safety and its rank among the nations to depend greatly on the perfection to which their knowledge of physics has brought their rifled artillery (as made by Armstrong, Whitworth, and others), their iron-clad ships, and other parts of their military engineering; the land-owner, in making improvements on his estates, buildings, draining, irrigating, road-making, &c.; the farmer, equally in these particulars, and in all the machinery of agriculture; the manufacturer, of course, to the widest extent; the merchant who has to purchase and distribute over the world the products of manufacturing industry—all these are interested in Physics; and even the man of letters, that he may not, in drawing illustrations from the material world, repeat the scientific heresies and absurdities which have heretofore prevailed, and which, by shocking the now better informed public, would lower the estimation in which literature would be held: and, lastly, parents of either sex, whose conversation and example have such powerful effect on the character of their children, quickly rising to be their successors;—all should have knowledge of physics, as one important part of their educational acquirements."

Notes.

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Omnibuses.—The importance of omnibus locomotion to Londoners is illustrated by the fact that an average of no less than 137,000 passengers per day are carried by these vehicles. The statistics of metropolitan omnibus traffic are, for the half-year ending December, 1863:—Average number of omnibuses working daily, 583; of horses, 6,189; total number of miles run, 6,004,782; of passengers carried, 20,592,544; average receipts per mile run, 1s.; average fare per passenger carried, 3½d.; gross earnings for omnibus per day, £2 16s. 6d.; gross receipts during the half-year, £302,895 7s. 5d.; gross expenditure, £278,788 1s. 8d.; net profit (after allowing for a reduction in value of horse stock), £24,107 5s. 9d. The General Omnibus Company runs vehicles over 12,000,000 miles, and carries upwards of 41,000,000 passengers a year.

A Traveller in Italy writes:—"Obtaining refreshments when travelling is always attended with difficulty and discontent, even by rail; but always on Italian roads, by diligence or vetturino, it becomes most serious. I send you my experience, as it may be useful. Before leaving London I had an ordinary picnic basket, made of wicker work; in this was a tin box big enough for a chicken, a bottle of wine, tumbler, knives and forks, and a tea-making apparatus, the whole very compact, about 12 inches by 9 inches, and 6 inches deep; not at all too large to carry over one's shoulder. Where I slept, before retiring I ordered a chicken to be ready, cold, the next morning; and with this, wine and bread, a very fair dinner may be made on the road,—certainly immensely superior to the dirty, greasy, mutton cutlets which are the usual fare obtainable at short notice at a wayside inn."

Correspondence.

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Memorial Tablets.—Sir,—I would submit, as a subject for a prize or prizes, to be offered by the Society of Arts, designs for memorial tablets to distinguished persons, to be affixed to houses in which they were born or dwelt. Records of this kind have been publicly mentioned several times of late years, and the public probably would now like to have the opportunity of seeing what could be done in this way, and the cost at which they could be obtained in different materials, as mosaic, majolica, metal, terra cotta, &c. Mosaic especially might seem promising in effect, having the advantage also of affording a test on a small scale, not only of its appearance in exterior decoration in London, but also of its durability in the London atmosphere. A public portrait in mosaic with an inscription would form a simple and interesting record, and such as people might be ready to erect if they knew the cost and saw the effect. In Kensington there is a house in which Sir Isaac Newton lived, which might well receive such a recording tablet.—I am, &c., Epsilon.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Medical, 8½. Mr. Teevan, "On some Injuries to the Skull."
British Architects, 8.
Asiatic, 3.
Tues. ...Civil Engineers, 8. Mr. William Lloyd, "Description of the Santiago and Valparaiso Railway."
Statistical, 8. Mr. James Heywood, "The Resources of Brazil."
Pathological, 8.
Anthropological, 8.
Royal Inst., 3. Prof. Helmholtz, F.R.S., "The Natural Law of Conservation of Energy."
Wed. ....Society of Arts, 8. Mr. Thomas Webster, F.R.S., "On the Patent Laws."
Meteorological, 7.
R. Society of Literature, 4. Annual Meeting.
Thur. ...Society of Arts, 8. Cantor Lectures. Dr. Crace Calvert, "On Chemistry applied to the Arts—Animal Fatty Matters, &c."
Royal, 8½.
Linnæan, 8. 1. Dr. W. Baird, "On New Species, &c , of Annelids in the Collection of the British Museum." Rev. T. A. Marshall, "On the *Eumolphidæ*, a Group of Phytophagous Cleoptera."
Chemical, 8. Mr. J. T. Way, "Philosophy of British Agriculture."
Numismatic, 7.
R. Society Club, 6.
Royal Inst., 3. Prof. Helmholtz, "Natural Law of Conservation of Energy."
Fri. ....Royal Inst., 8. Prof. Blackie, "On Lycurgus."
R. United Service Inst., 3. Major Talbot Harvey, "The Progressive and Possible Development of Infantry Drill and Manœuvres."
Sat ......R. Rotanic, 3¾.
Royal Inst., 3. Prof. Frankland, "On the Metallic Elements."
Antiquaries, 2. Annual Meeting.

PARLIAMENTARY REPORTS.

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SESSIONAL PRINTED PAPERS.

Par.
Numb.

SESSION 1863.

467. New Zealand (Native Affairs)—Return (delivered 4th March)

Delivered on 8th March, 1864.

19. Railway and Canal, &c. Bills (195. Shrewsbury and Potteries Junction Railway; 196. Teign Valley Railway; 197. Ardrossan Harbour; 198. Bute Docks (Cardiff); 199. Exe Valley Railway; 200. Gloucestershire and Wiltshire Railway; 201. Llanelly Harbour Improvement; 202. Southampton and Netley Railway; 203. Waterford and Limerick, Limerick and Foynes, and Rathkeale and Newcastle Junction Railways; 204. Weald of Kent Railway; 205. Western super Mare Pier; 206. Whitby Water; 207. Hartlepool Port and Harbour; 208. Commercial Docks and Grand Surrey Docks and Canal; 209. Dublin and Baltinglass Junction Railway; Dublin and Belfast Junction Railway)—Board of Trade Reports.
90. General or Quarter Sessions (Middlesex, &c.)—Return.
100. Kertch Grant—Return.
65. Central Asia—Mr. Davie's Report.

Delivered on 9th March, 1864.

19. Railway and Canal, &c. Bills (210. Ilfracombe Railway); 211. Llynvi Valley and Ogmore Valley Railway; 212. Manchester and Milford Railway; 213. Much Wenlock and Severn Junction and Wenlock Railway Companies Amalgamation; 214. Rhymney Railway (Cardiff to Caerphilly, &c.); 215. Swansea Harbour Trust; 216. Vale of Crickhowell Railway; 217. Workington Harbour)—Board of Trade Reports.

Patents.

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From Commissioners of Patents Journal, April 1st.

Grants of Provisional Protection.

Axles, lubricating of railway—753—W. A. Torrey.
Coal, hewing of—607—W. W Burdon.
Engines, motive power—725—W. Home.
Gaseliers, &c., additions to—751—I. Barnes.
Mashing, apparatus for—745—C. Garton and T. Hill.
Scum, removing of—699—C. Heywood.
Sewing, &c., machinery for—215—L. Lindley and F. Taylor.
Ships, coating of—351—M. C. de C. Sinibaldi.
Sizing, dressing, &c., apparatus for—639—T. Parkinson, F. Taylor, and T. Burton.
Smoke valve—603—T. Boyle.
Spinning, machinery for—699—J. H. Albinson and J. Collier.
Woollen fabrics, &c., clearing blemishes from—629—L. A. Durrieu.

Inventions with Complete Specifications Filed.

Railways, construction of—789—H. A. Bonneville.
Railways, &c.—832—C. D. Tisdale.

Patents Sealed.

2478. J. McInnes.
2484. G. W. Reynolds.
2488. W. B. Fairbanks, J. Lavender, and F. Lavender.
2496. J. Heap.
2498. T. Browning.
2500. T. Fox.
2505. J. J. Anderton.
2506. J. Dodge.
2508. J. E. Poynter.
2512. T. Scott.
2519. J. Milton.
2538. S. Berrisford and W. Ainsworth.
2539. J. Shanks.
2540. W. Hampson, jun.
2564. J. Vaughan.
2772. W. Clark.

From Commissioners of Patents Journal, April 5th.

Patents Sealed.

2524. R. Bewley, jun.
2527. S. R. Smith.
2529. B. F. Weatherdon.
2531. J. Polglase and J. Cox.
2534. F. A. E. G. de Massas.
2536. S. Jay.
2550. F. de Wylde.
2554. W. Fletcher.
2555. A. Budenberg.
2566. W. Snell.
2568. M. Pettenkofer.
2579. T. C. Clarkson.
2580. J. Hinton.
2583. G. Howell.
2588. Z. Colburn.
2596. A. A. Croll.
2602. John Weems.
2623. W. Betts.
2628. F. B. Baker.
2638. F. Parker.
2669. M. Henry.
2685. W. Gadd, jun.
2695. J. Brigham and R. Bickerton.
2704. J. H. Brown.
2884. J. H. Johnson.
2927. J. H. Johnson.
34. G. T. Bousfield.
142. E. J. Vinot.
156. J. Wilson.
318. G. T. Bousfield.
380. T. Jackson.

Patents on which the Stamp Duty of £50 has been Paid.

841. R. B. Greenwood.
876. F. Taylor.
909. J. Silvester.
854. J. H. Johnson.
858. H. Wilde.
1009. E. H. Bentall.
1027. E. H. Bentall.
1106. P. Wright.
872. J. Higgins and T. S. Whitworth.
908. J. R. Cooper.
910. A. F. Delannoy.
911. G. Graham.
892. T. Don, T. Smith, and L. Horsfield.
899. J. M. Dunlop.
903. J. Ward & R. Greenwood.
906. J. C. Rivett.
978. J. Whitehouse.

Patents on which the Stamp Duty of £100 has been paid.

961. S. Clarke.
1896. J. J. H. Brianchon.
1046. P. McFarlane.
1051. J. Rubery.
1028. T. N. Pengelly and G, Porter.
1369. C. Bartholomew and J. Heptinstall.

Registered Designs.

◆

Sash Fastener—4627—March 17—Hammond and Purrott, Croydon.
Shooting Jacket and Vest—4628—April 4—John Q. Bird, 13, Regent-street, W.
Revolving apparatus for Washing or Discharging Chemicals from Photographic Prints or Pictures—4629—April 8—George Williams, 1, Rhode-place, Holloway.
Perambulator and Sun and Rain Shade—4630—April 9—Henry Lloyd and J. H. Miles, Birmingham.